DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
9200 Corporate Boulevard
Rockville MD 20850

Ms. Mary Adams
Senior Regulatory Affairs Specialist
Cordis Webster, Inc.
4750 Littlejohn Street
Baldwin Park, California 91706

SEP 30 1997

Re: P950005
Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter
Filed: July 25, 1995
Amended: February 8, September 24 and 25, 1996; May 1 and 27, and August 29, 1997

Dear Ms. Adams:

The Center for Devices and Radiological Health (CDRH) of the Food and Drug Administration (FDA) has completed its review of your premarket approval application (PMA) for the Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter. This device includes the following models: six curve types (A, B, C, D, E, and F); tip electrode (4mm tip large and grooved); connector type [Redel 10-pin connector (temperature sensing version) and Nexus plug (non-temperature-sensing version)]; spacing [standard 2-5-2 spacing (center to center measurement of ring electrode spacing)]. This device is indicated for cardiac electrophysiological mapping and for use with a compatible RF generator for: interruption of accessory atrioventricular (AV) conduction pathways associated with tachycardia; the treatment of AV nodal re-entrant tachycardia; and, creation of complete AV nodal block in patients with a difficult to control ventricular response to an atrial arrhythmia.

We are pleased to inform you that the PMA is approved subject to the conditions described below and in the "Conditions of Approval" (enclosed). You may begin commercial distribution of the device upon receipt of this letter.

The sale, distribution, and use of this device are restricted to prescription use in accordance with 21 CFR 801.109 within the meaning of section 520(e) of the Federal Food, Drug, and Cosmetic Act (the act) under the authority of section 515(d)(1)(B)(ii) of the act. FDA has also determined that to ensure the safe and effective use of the device that the device is further restricted within the meaning of section 520(e) under the authority of section 515(d)(1)(B)(ii) insofar as the sale, distribution, and use must not violate sections 502(q) and (r) of the act.

Expiration dating for this device has been established and approved at 3 years. This is to advise you that the protocol you used to establish this expiration dating is considered an approved protocol for the purpose of extending the expiration dating as provided by 21 CFR 814.39(a)(8).

CDRH will publish a notice of its decision to approve your PMA in the FEDERAL REGISTER. The notice will state that a summary of the safety and effectiveness data upon which the approval is based is available to the public upon request. Within 30 days of publication of the notice of approval in the FEDERAL REGISTER, any interested person may seek review of this decision by requesting an opportunity for administrative review, either through a hearing or review by an independent advisory committee, under section 515(g) of the act.

Failure to comply with the conditions of approval invalidates this approval order. Commercial distribution of a device that is not in compliance with these conditions is a violation of the act.

You are reminded that, as soon as possible and before commercial distribution of your device, you must submit an amendment to this PMA submission with copies of all approved labeling in final printed form.

All required documents should be submitted in triplicate, unless otherwise specified, to the address below and should reference the above PMA number to facilitate processing.

PMA Document Mail Center (HFZ-401)
Center for Devices and Radiological Health
Food and Drug Administration
9200 Corporate Blvd.
Rockville, Maryland 20850

If you have any questions concerning this approval order, please contact Barbara Zimmerman at (301) 443-8517.

Sincerely yours,

Susan Alpert, Ph.D., M.D.
Director
Office of Device Evaluation
Center for Devices and
Radiological Health

Enclosure

Issued: 3-4-98

CONDITIONS OF APPROVAL

APPROVED LABELING. As soon as possible, and before commercial distribution of your device, submit three copies of an amendment to this PMA submission with copies of all approved labeling in final printed form to the PMA Document Mail Center (HFZ-401), Center for Devices and Radiological Health, Food and Drug Administration (FDA), 9200 Corporate Blvd., Rockville, Maryland 20850.

ADVERTISEMENT. No advertisement or other descriptive printed material issued by the applicant or private label distributor with respect to this device shall recommend or imply that the device may be used for any use that is not included in the FDA approved labeling for the device. If the FDA approval order has restricted the sale, distribution and use of the device to prescription use in accordance with 21 CFR 801.109 and specified that this restriction is being imposed in accordance with the provisions of section 520(e) of the act under the authority of section 515(d)(1)(B)(ii) of the act, all advertisements and other descriptive printed material issued by the applicant or distributor with respect to the device shall include a brief statement of the intended uses of the device and relevant warnings, precautions, side effects and contraindications.

PREMARKET APPROVAL APPLICATION (PMA) SUPPLEMENT. Before making any change affecting the safety or effectiveness of the device, submit a PMA supplement for review and approval by FDA unless the change is of a type for which a "Special PMA Supplement-Changes Being Effected" is permitted under 21 CFR 814.39(d) or an alternate submission is permitted in accordance with 21 CFR 814.39(e). A PMA supplement or alternate submission shall comply with applicable requirements under 21 CFR 814.39 of the final rule for Premarket Approval of Medical Devices.

All situations which require a PMA supplement cannot be briefly summarized, please consult the PMA regulation for further guidance. The guidance provided below is only for several key instances.

A PMA supplement must be submitted when unanticipated adverse effects, increases in the incidence of anticipated adverse effects, or device failures necessitate a labeling, manufacturing, or device modification.

A PMA supplement must be submitted if the device is to be modified and the modified device should be subjected to animal or laboratory or clinical testing designed to determine if the modified device remains safe and effective.

A "Special PMA Supplement - Changes Being Effected" is limited to the labeling, quality control and manufacturing process changes specified under 21 CFR 814.39(d)(2). It allows for the addition of, but not the replacement of previously approved, quality control specifications and test methods. These changes may be implemented before FDA approval upon acknowledgment by FDA that the submission is being processed as a "Special PMA Supplement - Changes Being Effected." This acknowledgment is in addition to that issued by the PMA Document Mail Center for all PMA supplements submitted. This procedure is not applicable to changes in device design, composition, specifications, circuitry, software or energy source.

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Alternate submissions permitted under 21 CFR 814.39(e) apply to changes that otherwise require approval of a PMA supplement before implementation of the change and include the use of a 30-day PMA supplement or annual postapproval report. FDA must have previously indicated in an advisory opinion to the affected industry or in correspondence with the applicant that the alternate submission is permitted for the change. Before such can occur, FDA and the PMA applicant(s) involved must agree upon any needed testing protocol, test results, reporting format, information to be reported, and the alternate submission to be used.

POSTAPPROVAL REPORTS. Continued approval of this PMA is contingent upon the submission of postapproval reports required under 21 CFR 814.84 at intervals of 1 year from the date of approval of the original PMA. Postapproval reports for supplements approved under the original PMA, if applicable, are to be included in the next and subsequent annual reports for the original PMA unless specified otherwise in the approval order for the PMA supplement. Two copies identified as "Annual Report" and bearing the applicable PMA reference number are to be submitted to the PMA Document Mail Center (HFZ-401), Center for Devices and Radiological Health, Food and Drug Administration, 9200 Corporate Blvd., Rockville, Maryland 20850. The postapproval report shall indicate the beginning and ending date of the period covered by the report and shall include the following information required by 21 CFR 814.84:

(1) Identification of changes described in 21 CFR 814.39(a) and changes required to be reported to FDA under 21 CFR 814.39(b).

(2) Bibliography and summary of the following information not previously submitted as part of the PMA and that is known to or reasonably should be known to the applicant:

(a) unpublished reports of data from any clinical investigations or nonclinical laboratory studies involving the device or related devices ("related" devices include devices which are the same or substantially similar to the applicant's device); and

(b) reports in the scientific literature concerning the device.

If, after reviewing the bibliography and summary, FDA concludes that agency review of one or more of the above reports is required, the applicant shall submit two copies of each identified report when so notified by FDA.

ADVERSE REACTION AND DEVICE DEFECT REPORTING. As provided by 21 CFR 814.82(a)(9), FDA has determined that in order to provide continued reasonable assurance of the safety and effectiveness of the device, the applicant shall submit 3 copies of a written report identified, as applicable, as an "Adverse Reaction Report" or "Device Defect Report" to the PMA Document Mail Center (HFZ-401), Center for Devices and Radiological Health, Food and Drug Administration, 9200 Corporate Blvd., Rockville, Maryland 20850 within 10 days after the applicant receives or has knowledge of information concerning:

(1) A mix-up of the device or its labeling with another article.

(2) Any adverse reaction, side effect, injury, toxicity, or sensitivity reaction that is attributable to the device and

(a) has not been addressed by the device's labeling or

(b) has been addressed by the device's labeling, but is occurring with unexpected severity or frequency.

(3)Any significant chemical, physical or other change or deterioration in the device or any failure of the device to meet the specifications established in the approved PMA that could not cause or contribute to death or serious injury but are not correctable by adjustments or other maintenance procedures described in the approved labeling. The report shall include a discussion of the applicant's assessment of the change, deterioration or failure and any proposed or implemented corrective action by the applicant. When such events are correctable by adjustments or other maintenance procedures described in the approved labeling, all such events known to the applicant shall be included in the Annual Report described under "Postapproval Reports" above unless specified otherwise in the conditions of approval to this PMA. This postapproval report shall appropriately categorize these events and include the number of reported and otherwise known instances of each category during the reporting period. Additional information regarding the events discussed above shall be submitted by the applicant when determined by FDA to be necessary to provide continued reasonable assurance of the safety and effectiveness of the device for its intended use.

REPORTING UNDER THE MEDICAL DEVICE REPORTING (MDR) REGULATION. The Medical Device Reporting (MDR) Regulation became effective on December 13, 1984. This regulation was replaced by the reporting requirements of the Safe Medical Devices Act of 1990 which became effective July 31, 1996 and requires that all manufacturers and importers of medical devices, including in vitro diagnostic devices, report to the FDA whenever they receive or otherwise become aware of information, from any source, that reasonably suggests that a device marketed by the manufacturer or importer:

(1)May have caused or contributed to a death or serious injury; or

(2)Has malfunctioned and such device or similar device marketed by the manufacturer or importer would be likely to cause or contribute to a death or serious injury if the malfunction were to recur.

The same events subject to reporting under the MDR Regulation may also be subject to the above "Adverse Reaction and Device Defect Reporting" requirements in the "Conditions of Approval" for this PMA. FDA has determined that such duplicative reporting is unnecessary. Whenever an event involving a device is subject to reporting under both the MDR Regulation and the "Conditions of Approval" for a PMA, the manufacturer shall submit the appropriate reports required by the MDR Regulation within the time frames as identified in 21 CFR 803.10(c) using FDA Form 3500A, i.e., 30 days after becoming aware of a reportable death, serious injury, or malfunction as described in 21 CFR 803.50 and 21 CFR 803.52 and 5 days after becoming aware that a reportable MDR event requires remedial action to prevent an unreasonable risk of substantial harm to the public health. The manufacturer is responsible for submitting a baseline report on FDA Form 3417 for a device when the device model is first reported under 21 CFR 803.50. This baseline report is to include the PMA reference number. Any written report and its envelope is to be specifically identified, e.g., "Manufacturer Report," "5-Day Report," "Baseline Report," etc. Any written report is to be submitted to:

Food and Drug Administration
Center for Devices and Radiological Health
Medical Device Reporting
PO Box 3002
Rockville, Maryland 20847-3002

Copies of the MDR Regulation (FOD # 336&1336)and FDA publications entitled "An Overview of the Medical Device Reporting Regulation" (FOD # 509) and "Medical Device Reporting for Manufacturers" (FOD #987) are available on the CDRH WWW Home Page. They are also available through CDRH's Fact-On-Demand (F-O-D) at

800-899-0381. Written requests for information can be made by sending a facsimile to CDRH's Division of Small Manufacturers Assistance (DSMA) at 301-443-8818.

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Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter

Summary of Safety and Effectiveness Data

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Summary of Safety and Effectiveness Data

1. General Information

Device Generic Name: ..... Diagnostic/Ablation Deflectable Tip Catheter

Device Trade Name: ..... Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter

Cordis Webster Celsius™ Diagnostic/Ablation Deflectable Tip Catheter - Thermocouple

Device Model Numbers: ..... D6-[A,B,C,D,E,F][L,G]-252-[PS] - 6F, non-temperature sensing

D6TC-[A,B,C,D,E,F][L,G]-252-[RT] - 6F, temperature sensing

D7-[A,B,C,D,E,F][L,G]-252-[PS] - 7F, non-temperature sensing

D7TC-[A,B,C,D,E,F][L,G]-252-[RT] - 7F, temperature sensing

where [A,B,C,D,E,F] indicates 6 available curve types, [L,G] denotes large (L) or grooved (G) 4mm tip electrode, [PS,RT] indicates a sterilized catheter with a plug (PS) connector or Redel connector (RT), and 252 indicates ring electrode spacing which typically is "52" (5mm between the centers of ring electrodes 1 and 2, and 2mm between the centers of ring electrodes 2 and 3).

C6-MR10/MLTC-S - Interface Cable to compatible generator

Applicant's Name and Address: ..... Cordis Webster, Inc
4750 Littlejohn Street
Baldwin Park, CA 91706

PMA Application Number: P950005

Date of Panel Recommendation: ..... none

Date of Notice of Approval to the Applicant.... September 30, 1997

2. Indications for Use

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter is indicated for cardiac electrophysiological mapping and for use with a compatible RF generator (see section 6) for:

- interruption of accessory atrioventricular (AV) conduction pathways associated with tachycardia;
- the treatment of AV nodal re-entrant tachycardia; and
- creation of complete AV nodal block in patients with a difficult to control ventricular response to an atrial arrhythmia.

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3. Contraindications

Do not use this device;

- in patients with active systemic infection;
- via the transseptal approach in patients with left atrial thrombus or myxoma, or interatrial baffle or patch;
- via the retrograde transaortic approach in patients with aortic valve replacement.

4. Warnings and Precautions

4.1 Warnings

Significant x-ray exposure, can result in acute radiation injury as well as increased risk for somatic and genetic effects due to the x-ray beam intensity and duration of the fluoroscopic imaging. Take all appropriate measures to minimize x-ray exposure to both patients and clinical staff.

Pregnancy -- Careful consideration should be given to the use of this device in pregnant women.

Ablation from within a coronary artery can cause myocardial injury and death. Adequate fluoroscopic visualization is necessary during the transaortic approach to avoid placement of the ablation catheter in the coronary vasculature.

Stroke or myocardial infarction may occur in patients undergoing **left-sided ablation procedures.** Patients should be closely monitored during the post-ablation period for clinical manifestations of embolic events.

Implantable pacemakers and implantable cardioverter/defibrillators (ICDs) may be adversely affected by RF ablation. ICDs should be deactivated during ablation. Have temporary external sources of pacing and defibrillation available during ablation. Exercise extreme caution during ablation when in close proximity to device leads and perform a complete analysis of the implanted device after ablation.

Complete AV block can occur when ablating septal accessory pathways or in the treatment of AVNRT. Closely monitor AV conduction during RF energy delivery and immediately terminate energy delivery if partial or complete AV block is observed. Using catheters with **distal pair electrode spacing greater than 2 mm** may increase the risk of AV nodal damage.

4.2 Precautions

Cardiac ablation procedures should be performed only by appropriately trained personnel in a fully-equipped electrophysiology laboratory.

Do not attempt to operate the Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter or the radio frequency generator prior to completely reading and understanding the applicable directions for use.

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4.2.1 Catheter Compatibility

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter is intended for use with compatible the Medtronic Atakr RF Power Generator radio frequency generators and Cordis Webster accessories only.

Read and follow the dispersive electrode manufacturer's instructions for use; the use of dispersive electrodes, which meet or exceed ANSI/AAMI requirements (HF18), is recommended.

4.2.2 Handling and Sterilization

SINGLE USE ONLY. Observe "Use By" Date. Sterilized with ethylene oxide gas.

The sterile packaging and catheter should be inspected prior to use. If the package or the catheter appears damaged, do not use. Contact your local Cordis Webster representative.

Catheter damage may occur due to

- autoclaving
- resterilizing
- exposure to organic solvents
- immersing proximal handle or cable connector in fluids

4.2.3 Environmental and EMI

Catheter materials are not compatible with magnetic resonance imaging (MRI).

Electromagnetic interference (EMI) produced by catheter may adversely affect the performance of other equipment.

4.2.4 Precautions During Catheter Use

The patient **should not contact grounded metal surfaces**. **Use only isolated amplifiers, pacing equipment, and ECG equipment** or patient injury or death may occur. Leakage current from any connected device to the patient must not exceed 10 microAmps (μA) under any circumstances.

Do not use excessive force to advance or withdraw the catheter. Careful catheter manipulation must be performed in order to avoid cardiac damage, perforation, or tamponade.

Do not insert or withdraw the catheter without straightening the catheter tip (pulling the thumb knob back)

Do not use the catheter if the small vent area at the connector end of the handpiece is clogged since air may be forced into the catheter lumen and into the bloodstream.

Use both **fluoroscopy and electrograms** to monitor the advancement the catheter to the area of the endocardium under investigation to avoid vascular or cardiac damage.

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4.2.5 Precautions during Ablation

Do not increase power before checking for lead connection and appropriate dispersive electrode application. Effective contact between the patient and the dispersive electrode must be verified whenever the patient is repositioned.

Do not deliver RF energy with catheter outside the target site. The RF generator can deliver significant electrical energy and may cause patient or operator injury.

Avoid use of electrodes and probes of monitoring and stimulating devices which could provide paths for high frequency current. Reduce the burn hazard by placing the electrodes and probes as far away as possible from the ablation site and the dispersive electrode.

In the event of a generator cutoff (impedance or temperature), the catheter must be withdrawn and the tip electrode cleaned of coagulum before radio frequency current is re-applied. Use only sterile saline and gauze pad to clean the tip.

Do not scrub or twist the tip electrode as damage may cause catheter failure or patient injury.

Discontinue ablation immediately and replace catheter if tip temperature fails to rise during ablation (temperature sensing version).

The temperature sensing version of the catheter measures electrode tip temperature, not tissue temperature. If the generator does not display temperature (temperature sensing version), verify that the appropriate cable is plugged into the generator. If temperature still is not displayed, there may be a malfunction in the temperature sensing system which must be corrected prior to applying RF power.

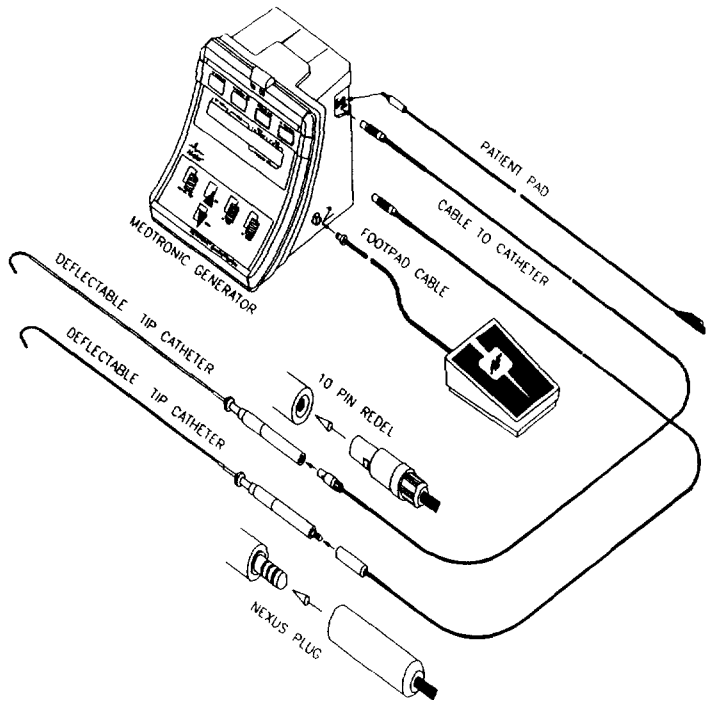
5. Device Description

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter is a multi-electrode device which provides electrophysiological mapping of the heart and transmits radio frequency current to the catheter tip electrode for ablation purposes. For ablation, the catheter is used in conjunction with a compatible RF generator and a dispersive pad (reference electrode). Both temperature sensing and standard model catheters are available.

The catheter has a high-torque shaft with a deflectable tip section containing an array of platinum electrodes. All electrodes may be used for recording and stimulation, but only the tip electrode may be used to deliver radio frequency (RF) energy from the generator.

Tip deflection is controlled at the proximal end by a tubular handpiece in which a piston slides; a thumb knob on the piston controls piston travel. The plane of the curved tip can be rotated and the shape of the curve depends on the deflectable tip length. Six different curves, designated "A" through "F" (from 1.5" to 3.0" radius) are available. The catheter interfaces with standard recording equipment and a compatible radio frequency generator via accessory extension cables with the appropriate connectors.

Figure 1. System Schematic



The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter should be used only with a compatible RF generator which has been shown to be safe and effective for cardiac ablation. Table 1 lists compatible RF generator specifications.

Table 1. Specifications for a Compatible RF Generator

Generator	Specification
Thermometry	Thermocouple
Temperature Limit, maximum	100°C
Modes: (must operate in all 3 modes)	1. Temperature Control 2. Temperature Monitoring 3. Power Control
Maximum Output Power	50 Watts
RF output frequency	450kHz - 550kHz
Impedance cuttoff	high: 250Ω low: 40Ω

6. Alternative Practices or Procedures

Alternative therapy includes direct surgical ablation, use of drugs for tachycardia control, and antitachycardia pacing.

7. Marketing History

In the U.S., the Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter with or without thermocouple has not been marketed for ablation of accessory atrioventricular connections.

Cordis Webster thermocouple catheters have been marketed for ablation since 1995 in the following countries: Germany, Italy, France, Spain, the United Kingdom, Belgium, Austria, the Netherlands, Switzerland, Sweden, and South Africa.

There have been no countries from which the device has been withdrawn from marketing for any reason related to safety or effectiveness of the device.

8. Adverse Effects of the Device on Health

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter was studied in patients undergoing electrophysiologic mapping and radio frequency (RF) catheter ablation. RF ablation was intended to eliminate atrioventricular (AV) accessory pathways (AP) associated with tachycardia, due to Wolff-Parkinson-White (WPW) syndrome, AV nodal re-entrant tachycardia (AVNRT), or creation of complete AV block in patients with difficult to control ventricular response to an atrial arrhythmia. A total of 755 patients forms the safety database and represents those patients treated with both non-temperature sensing and temperature sensing versions of the catheter. The Temperature Control Study involved 171 patients treated with a temperature sensing catheter. The Temperature Monitoring Study involved 584 patients treated with both a temperature sensing catheter and a non-temperature sensing catheter.

One patient died about 36 hours after transseptal puncture for left heart ablation. The investigational catheter was not used to deliver energy in this patient.

8.1 Observed Adverse Events

Table 2 is a summary of the observed adverse events and Table 3 lists the fluoroscope time. Eleven patients reported a major device or procedure adverse event defined as heart block requiring pacemaker or other adverse event requiring medical intervention or prolonged hospitalization. The 11 events included complete heart block in 7 patients (6 requiring a pacemaker), two developed pericardial tamponade, one transient ischemic event, and intubation required in one patient with chronic obstructive lung disease.

Serious, related complications were reported in 11 patients including unintended heart block requiring a pacemaker in three patients, and post-procedure intubation in one patient with chronic obstructive lung disease.

One fourth (26%) of patients reported one or more minor adverse events including dizziness, dyspnea, palpitations, chest pain, gastrointestinal symptoms, vision abnormalities, edema and claudication.

Table 2. Observed Adverse Events

Categories are mutually exclusive; all patients treated with ablation (N=755)

Adverse Event	%	#	95% Confidence Interval*	
Minor	26%	(196/755)	23%	29%
Major	1.5%	(11/755)	0.73%	2.6%
Death	0.13%	(1/755)	0.0%	0.7%

** Confidence intervals by exact (binomial) method*

Table 3. Fluoroscope Time by Indication

All patients treated with fluoroscope time measurement (N=580)

Catheter	Indication	Fluoroscopy Time (min) mean ± SD (range)
Non-Temperature	WPW	36 ± 37 (1, 248)
Non-Temperature	AVNRT	23 ± 21 (2, 255)
Temperature	WPW	44 ± 41 (1, 223)
Temperature	AVNRT	24 ± 22 (1, 129)

8.2 Potential Adverse Events

Adverse events (in alphabetical order) which may be associated with catheterization and ablation include:

Catheterization/catheter procedure related:

- air embolism
- arrhythmias
- AV fistula
- cardiac perforation
- hemothorax
- pneumothorax
- pseudoaneurysm
- tamponade
- thrombi
- thromboembolism
- thrombosis
- valvular damage
- vascular bleeding/local hematomas
- vasovagal reactions

Radio frequency related:

- cardiac perforation/tamponade
- cardiac thromboembolism
- cerebrovascular accident (CVA)
- chest pain/discomfort
- complete heart block
- coronary artery dissection
- coronary artery spasm
- coronary artery thrombosis
- pericarditis
- transient ischemic event (TIA)
- valvular damage
- ventricular tachyarrhythmia

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According to published literature, serious adverse events/complications typically occur during ablation in 3% to 5% of procedures. These adverse events/complications are listed in Tables 4 and 5 along with the number and percentage of events reported in the Temperature Control Study (n=171) using a market approved RF generator

Table 4. Major Adverse Events/Complications - Temperature Control Study

All patients in the temperature control study (n=171)

Adverse Event/Complication (Major)	Number of Adverse Events	Total Percentages
Death		
Complete Heart Block	3	2%
Perforation		
Transient Heart Block		
Confusion and Headache		
Pericardial Hematoma		
Post-Procedure Intubation[1]	1	1%

[1] Due to pre-existing chronic obstructive pulmonary disease (COPD)

Table 5. Minor Adverse Events/Complications - Temperature Control Study

All patients in the temperature control study (n=171)

Adverse Event/Complication (Minor)	Number of Adverse Events	Total Percentages
Dizziness, lightheadedness		
Vision abnormalities	1	1%
Focal weakness, sensory abnormalities		
Chest pain	2	1%
Dyspnea, cough	1	1%
Edema		
Palpitations suggestive of recurrent tachyarrhythmias	4	2%
Minor palpitations not suggestive of arrhythmias related to an accessory pathway	29	17%
Claudication or other problems with extremities	1	1%
Gastrointestinal symptoms	1	1%

Tables 6 and 7 list the adverse events/complications from the literature along with the number and percentage of adverse events/complications reported in the Temperature Monitoring Study (n=584) using another RF generator shown to produce similar lesions:

Table 6. Major Adverse Events/Complications - Temperature Monitoring Study

All patients in the temperature monitoring study (n=584)

Adverse Event/Complication (Major)	Number of Adverse Events	Total Percentages
Death[1]	1	<1%
Complete Heart Block	1	<1%
Perforation		
Transient Heart Block		
Confusion and Headache	1	<1%
Pericardial Hematoma	1	<1%
Post-Procedure Intubation		

[1] The patient died two days after surgery. The cause of death was myocardial infarction secondary to cardiac perforation and severe coronary disease.

Table 7. Minor Adverse Events/Complications - Temperature Monitoring Study

All patients in the temperature monitoring study (n=584)

Adverse Event/Complication (Minor)	*Number of Adverse Events*	*Total Percentages*
Dizziness, lightheadedness	85	13%
Vision abnormalities	26	4%
Focal weakness, sensory abnormalities	33	5%
Chest pain	81	12%
Dyspnea, cough	67	10%
Edema	21	3%
Palpitations suggestive of recurrent tachyarrhythmias	70	11%
Minor palpitations not suggestive of arrhythmias related to an accessory pathway	291	35%
Claudication or other problems with extremities	30	5%
Gastrointestinal symptoms	47	7%
HEENT	16	2%
Chest	19	2%
Cardiac	39	5%
Abdomen	10	1%
Peripheral vascular system	17	2%
Neurological system	14	2%
Other	23	3%

9. Summary of Preclinical Studies

9.1 Laboratory Studies

Design validation of the deflectable catheter and cable was performed according to Cordis Webster's Product Development Protocol (PDP) consistent with ANSI standards for Electrosurgical Devices (HF-18), AAMI standards for ECG connectors (ECGC), and FDA guidance on data to be submitted in support of Premarket Notifications for electrode recording catheters.

Production catheters sterilized 3 times and production cables sterilized 10 times were subjected to a ten-step validation testing protocol. Additional tests were performed on temperature sensing catheters, as appropriate.

9.1.1 Reliability

Catheter and Cable Bond Strength - The strength of each bond in the deflectable catheter and cable was determined. Average catheter and cable break forces were calculated. All catheter bonds were sufficiently strong to withstand the maximum force exerted during a procedure which is estimated to be approximately 2.0 pounds. Cables were able to withstand the nominal limits for break force.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Entire catheter	9	2 lbs.	All samples passed.
Tip electrode to tip joint	6	2 lbs.	All samples passed.
Body to deflecting tip	6	2 lbs.	All samples passed.
Body to piston	9	2 lbs.	All samples passed.
Cable (Connection to generator end)	2	7 lbs.	All samples passed.
Cable (Connection to catheter end)	2	12.5 lbs.	All samples passed.

Additional mechanical reliability testing was conducted on temperature catheters and is summarized in the table below.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Entire catheter	15	4 lbs. (additional safety factor of 2)	All samples passed.
Body to deflecting tip	7	4 lbs. (additional safety factor of 2)	All samples passed.

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Torsional Testing - The durability of the catheter with respect to successive handle rotations was determined. Average torque and number of turns until failure were calculated. All catheters met the acceptance criteria for number of full turns prior to failure.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Torque and Number of Rotations to Failure			
Non-temperature samples	9	2 full turns	All samples passed.
Temperature samples	15	2 full turns	All samples passed.

Deflection Fatigue - Following 500 complete tip flex cycles, no catheters were observed to mechanically fail.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Deflection Life Test			
Non-temperature samples	15	No mechanical failures before 500 deflections	All samples passed.
Temperature samples	15	No mechanical failures before 500 deflections	All samples passed.

Joint Seal - The integrity of all catheter joints was further documented by determining the gas pressure that resulted in leaks. All catheters achieved the acceptance level of 10 PSI without leaking. The catheter is subjected to a maximum pressure of 2.3PSI in the human heart.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Pressure Test			
Non-Temperature Catheter Samples	15	10 psi without leaks or fracture	All samples passed.
Temperature Catheter Samples	15	1.452 psi for a safety factor of 3	All samples passed.

Cable/Connector Testing - Accessory cables were subjected to cable/connector pull tests and flex fatigue tests to demonstrate the durability of the cables for repeated use. There were no significant changes in electrical performance and all measurements were within acceptable limits.

Engagement and separation forces were determined. The average force to insert the catheter into the mating extension cable was within the sponsor's acceptance limit. The average force to withdraw the catheter from the cable was also within the sponsor's acceptance limit.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Mechanical Integrity of the Cable (pull test)	3	> 7 lbs. > 12.5 lbs. (two types of connectors)	All samples passed.
Flex Fatigue Testing after Multiple Sterilization Cycles	10	After 50 flex cycles, no significant changes in resistance or leakage.	All samples passed.
Catheter/Cable (insertion/ withdrawal force)			
Non-temperature samples	15	< 10 lbs. to insert and > 1 lb. to withdraw	All samples passed.
Temperature samples	15	< 10 lbs. to insert and > 1 lb. to withdraw	All samples passed.

9.1.2 Mechanical Performance

Buckling Force - The catheter tip electrode was held against a force gauge and the catheter was pushed until the force plateaued. The results met the sponsor's specified limits.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Buckling Force (temperature catheter) samples)	15	< 30 grams	All samples passed.

Bending - Bending tests were performed where catheters were placed on a catheter stretcher. Increasing weights were placed on the catheter shafts and catheter deflection was measured from neutral. The results were acceptable.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Bending (temperature catheter samples)	15	For baseline purposes. (No acceptance criteria has been established.)	All samples passed.

Side Force - The force necessary to deflect the catheter tip while the device was in a test track (U-tube) was measured. All side loads were above the specified side-load minimum limit.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Tip Side Load Force			
Non-Temperature Catheter Samples	15	> 4 grams	All samples passed.
Temperature Catheter Samples	15	> 4 grams	All samples passed.

Simulated Use Diagnostic Procedure/Torsion - Changes in electrical parameters regarding continuity and isolation were characterized using a simulated 5 hour diagnostic/1 hour ablation procedure (ablation procedure described later). All catheters remained within acceptable limits for all qualitative (Pass/Fail) parameters including DC isolation, 5KHz isolation, RF isolation, and RF leakage. Following the simulated stressful diagnostic/ablation procedure, all catheters were within tolerance for DC resistance, DC isolation, 5KHz impedance, 5KHz isolation, RF impedance, RF isolation, shunt current and catheter RF leakage. Torque plots were generated to describe the relationship of handle turn (degrees) to torque (in-oz). Measurements were taken at baseline (after 3 sterilizations).

After a simulated 5 hour diagnostic procedure (5 hours of soaking in saline, 10 insertions in a 7FR introducer, 50 cycles of side-to-side rotation against a solid surface, 100 tip deflections, 50 more side-to-side rotations), the torque measurements were repeated. All measurements were acceptable.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Simulated 5-Hour Diagnostic Mapping Procedure in a Saline Bath			
Non-Temperature Catheter Samples	15	No mechanical failures.	All samples passed.
Temperature Catheter Samples	15	No mechanical failures.	All samples passed.

9.1.3 Electrical Performance

NOTE: In the temperature catheter testing, all catheter samples passed the initial electrical testing. Following simulated use diagnostic and ablation testing, one catheter had no DC resistance reading; therefore, 14 samples passed and one sample failed final electrical testing. The worst cae results are shown in the following tables:

DC Resistance, Isolation, Impedance - DC resistance and 5KHz impedance of each conductor were determined. Initial DC resistance of all catheters tested was under the specified limit of 10Ω. The DC electrical isolation limits were under the specified limit of 200Ω. The 5KHz impedance of all catheters fell within the same limits as for DC resistance. The 5KHz isolation was above the limit of 100KΩ for all catheters tested. All electrical testing was conducted under unsoaked and soaked conditions.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
DC Lead Resistance			
Non-Temperature Catheter Samples	15	< 10 Ω	All samples passed
Temperature Catheter Samples	15	< 10 Ω	14 samples passed, 1 sample failed
DC Isolation			
Non-Temperature Catheter Samples	15	> 200 kΩ	All samples passed.
Temperature Catheter Samples	15	> 200 kΩ	14 samples passed, 1 sample failed
5 KHz Lead Impedance			
Non-Temperature Catheter Samples	15	< 10 Ω	All samples passed.
Temperature Catheter Samples	15	< 10 Ω	14 samples passed, 1 sample failed
5 KHz Isolation			
Non-Temperature Catheter Samples	15	> 100 kΩ	All samples passed.
Temperature Catheter Samples	15	> 100 kΩ	14 samples passed, 1 sample failed

RF Impedance and Leakage - The RF impedance of all catheters tested was under the limit of 25 Ω. The RF leakage from the catheter body met the specification limit (reference HF-18) and was under the sponsor's acceptance criteria for all samples tested.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
RF Lead Impedance Non-Temperature Catheter Samples	15	< 25 Ω	All samples passed
Temperature Catheter Samples	15	< 25 Ω	14 samples passed, 1 sample failed
RF Isolation Non-Temperature Catheter Samples	15	> 1 kΩ	All samples passed.
Temperature Catheter Samples	15	> 1 kΩ	14 samples passed, 1 sample failed
Shunt Current (Non-Temperature Catheter Samples Only)	15	< .2 A	All samples passed.
Leakage Current (phase angle) (Temperature Catheter Samples Only)	15	A phase shift in the current of -86° to -90° with respect to the voltage	14 samples passed, 1 sample failed
Catheter Leakage Current Non-Temperature Catheter Samples	15	252 mA	All samples passed.
Temperature Catheter Samples	15	< 289 mA	14 samples passed, 1 sample failed

Simulated Use Ablation - Ablation testing was performed on beef heart in a saline bath following the simulated 5 hour diagnostic procedure.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Simulated Use Ablation Test Non-Temperature Catheter Samples	10	No mechanical failure, consistent lesions created.	All samples passed.
Temperature Catheter Samples	15	No mechanical failures, tip electrode should not loosen.	All samples passed.

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9.1.4 Environmental and Shipping Tests

Ten deflectable catheters (non-temperature) were subjected to a loose load vibration test (ASTM 4169 § 11.6) and a vehicle vibration test (ASTM 4169 § 11.7). Before and after each vibration test, a manual drop tests was performed (ASTM 4169 § 11.2). Following these tests, the catheters were temperature cycled 5 times between high temperature (60 C ± 2 C) and low temperature (-40 C ± 2 C) with a dwell time of 30 minutes (± 2 min) and a transfer time of no more than 30 minutes. After these environmental challenges, a complete final inspection of the catheters was performed. In addition, an abbreviated ablation simulation (15 lesions) was performed.

All environmentally challenged catheters were cosmetically, mechanically, electrically and functionally comparable to 15 control catheters. This demonstrates that the deflectable catheter can tolerate extreme shipping and storage conditions. Similar results were seen with temperature sensing catheters.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Simulated Ablation Procedure			
Non-Temperature Catheter Samples	10	No mechanical failure, consistent lesions created.	All samples passed.
Temperature Catheter Samples	6	No mechanical failure, consistent lesions created.	All samples passed.
Final Inspection (Non-Temperature and Temperature Catheter Samples)	10 6		
• DC Resistance		< 10 Ω	All samples passed.
• DC Leakage (Isolation)		> 200 kΩ	
• Thermocouple readings		2 ° C	

9.1.5 Temperature Measurements

Two sets of testing was performed on the deflectable catheter with temperature sensing capability. Thermocouple temperature accuracy from 37° C to 90° C was determined. Thermocouple temperature accuracy at 55° C during RF delivery was determined. Thermocouple response time from 30° C to 60° C was measured. All temperature readings were within 3 degrees of the nominal values. One catheter from Set #1 failed to read temperatures higher than 65°C. this catheter was not used in subsequent tests following the Thermocouple Temperature Accuracy test.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Temperature Accuracy at 5 Temperatures			
Set #1	At least 5, maximum 15	All readings within 3 °C of the nominal values	All samples passed except one
Set #2	15	All readings within 2 °C of actual temperature	All samples passed.
Thermocouple Temperature Accuracy at 55 °C During RF Delivery			
Set #1	At least 13, maximum 15	All readings within 3 °C of the nominal values	All samples passed.
Set #2	15	Temperature accuracy should be within 2 °C of actual temperature.	All samples passed.
Thermocouple Response Time			
Set #1	14	Response time should be <10 seconds for a time constant of 2 seconds.	All samples passed.
Set #2	15		All samples passed.

9.1.6 Diagnostic Capabilities of RF Catheters

The diagnostic capabilities of the Cordis Webster Diagnostic/Ablation Catheter were demonstrated during the clinical study on several mapping systems and the resulting electrograms showed that the diagnostic capabilities of the catheter were adequate.

9.1.7 Shelf Life of RF Catheters and Packaging

The tests evaluated the shelf life performance of the packaging materials and the RF Catheters. This included not only an evaluation of the integrity of the packaging materials and their ability to maintain an effective sterility barrier, but catheter performance as well. Microbial barrier testing as performed on the packaging materials and performance evaluation was performed on the catheters following accelerated aging. Based on the results of these tests, the data support expiration date labeling of a minimum of three years.

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Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Dust Drum Microbial Package Challenge	21 double package systems (10 test samples, 10 negative controls, and 1 positive control	Sterile following 55 ° C storage for 94 and 188 days	All samples passed.
Burst and Creep Testing	20	Integrity of the package must be maintained for 30 seconds	All samples passed except for some primary packages failing to withstand the Creep pressure.*
Seal Peel Testing	10	No deterioration of the package seal strength..	All samples passed.

* The results obtained from the microbial package challenge and Burst test showed that the integrity of the package was not compromised; therefore, this study qualified a shelf life claim of 3.0 years for the double package system.

9.1.8 Additional Testing

Electrical, Thermal, and Ablation Characteristics - Additional non-clinical laboratory testing was performed to show the equivalence of the Cordis Webster thermocouple catheter and interface cable to a market approved thermocouple catheter and interface cable. Because the Cordis Webster catheter had already been extensively tested, the additional testing was performed comparing electrical, thermal and ablation characteristics of the Cordis Webster catheter and cable to a market approved catheter. All results were satisfactory and there were no failures. The comparative data revealed similar characteristics between the Cordis Webster thermocouple catheter and the market approved catheter.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Simulated Use of Catheter/Cable System	6 (Cordis Webster catheter/cable system) 1 (market approved catheter/cable system.	Lesions created by the Cordis Webster catheter/cable system should be consistent with lesions created by the market approved catheter/cable system	All samples passed showing that lesions were consistent between systems.

Simulated Use Ablation and Lesion Comparison - Several Simulated Use Ablation and Lesion Comparison tests were performed with both thermocouple and non-thermocouple catheters, interface cables, and both the market approved RF generator and an investigational generator that was used in previous clinical studies. The results of the testing indicated that the lesions generated were similar with slight differences due to difficulty in measuring lesions and slight variations in impedance.

In addition, the tests indicated that lesion sizes produced in a simulated clinical setting using the comparative catheter/generator test systems are similar.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Simulated Use of Catheter/Cable System	**6** Cordis Webster catheter/cable systems used with the market approved generator system **1** Cordis Webster catheter/cable system used with the investigational generator system	Lesions created using the Cordis Webster catheter/cable and the market approved or investigational generator should be the same.	Lesion sizes between the two catheter/cable/ generator systems were similar, however not the same. The small variance shown is also seen in a clinical setting and has not shown to affect the safety or effectiveness of the catheter.

9.1.9 Biocompatibility Testing

All blood and tissue contact materials of the catheter were tested in accordance with relevant sections of the Tripartite Biocompatibility Guidance for Medical Devices. The biocompatibility of the catheter materials was established for the intended use.

Additional biocompatibility testing was performed according to the ISO 10993-4 hemocompatibility requirement, thrombogenicity and immunogenicity. Thrombogenicity testing was performed in two dogs and the results of the study showed that the test samples resisted thrombogenicity. Immunogenicity testing was performed on normal human serum using monoclonal antibodies and a highly immunogenic control article. The control materials used in this study performed as anticipated.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
USP Muscle Implantation Study	1 test article	Macroscopic reaction must not be significant.	Passed as a slight irritant.
In Vitro Cytotoxicity (MEM Elution)	1 test article	Neither of the monolayers exposed to the test medium may be greater than a grade 2 (mild).	Passed.
Delayed Contact Sensitization Study (A Maximization Method) in the Guinea Pig	2 test articles	No dermal inflammatory response greater than that seen in any control condition.	Samples passed.
Subchronic Intravenous Toxicity Study in Mice (Saline Extract)	1 test article	No evidence of systemic toxicity.	Passed.
USP Systemic Toxicity Study in Mice (Extracts)	1 test article	No mortality or evidence of significant systemic toxicity from the extracts.	Passed.

USP Intracutaneous Toxicity Study in the Rabbit (Extract)	1 test article	No evidence of significant irritation or toxicity from the extracts.	Passed.
Genotoxicity/Mutagenicity • Ames Test (Ethanol) • Ames Test (Saline) (The methodology of Ames et al (1975) was followed but modified to use a saline extract.)	1 test article 1 test article	No mutagenic changes. No mutagenic changes.	Passed. Passed.
Hemocompatibility/Hemolysis • Sensitization Challenge, Hemolysis (Saline) • Thromboresistance in Two Dogs (In Vivo) • Immunogenicity (C3a Complement Activation Assay)	1 test article 1 test article 1 test article	Must be non-hemolytic Must resist thrombogenicity Must not create an immune response.	Passed. Passed. Passed.
Material Mediated Pyrogen	1 test article	Rise of rabbit temperatures must be within USP limit.	Passed.
Comparative Study of Pre and Post Ablation Catheters	3 deflectable catheters	Multiple RF applications must not have an adverse effect on the biocompatibility of the catheter materials.	Passed.

9.2 Animal Studies

In addition to providing abstracts of published articles regarding animal testing of radiofrequency ablation, a canine study was performed to verify the effectiveness of the Cordis Webster non-temperature catheter used in conjunction with a radiofrequency generator (shown to deliver similar lesions to that of a market approved RF ablation system). The study concluded that radiofrequency current could be applied to the mitral annulus to produce discrete lesions without injuring the mitral valve or coronary artery. The thermocouple version of the catheter is identical in performance characteristics to the non-temperature version in terms of radiofrequency ablation.

Name of Test	Number of Devices Tested	Acceptance Criteria	Results of Testing
Evaluation of Webster RF Catheter Ablation System in Canines	1 catheter sample	Produce discrete lesions without injuring the mitral valve or coronary artery.	Passed.

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10. Summary of Clinical Studies

10.1 Objectives

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter was investigated in two clinical studies. The first study used both temperature sensing (thermocouple) and non-temperature sensing versions of the Cordis Webster catheter and an investigational RF generator to treat 584 patients undergoing electrophysiologic mapping and radiofrequency (RF) catheter ablation for elimination of atrioventricular (AV) accessory pathways (AP) associated with tachycardia, typically due to Wolff-Parkinson-White (WPW) syndrome, and AV nodal re-entrant tachycardia (AVNRT). This is referred to as the "Temperature Monitoring" study.

The second study used a temperature sensing version of the catheter (thermocouple) in conjunction with a market approved RF generator in a study of 177 patients undergoing electrophysiologic mapping; 171 of these patients subsequently undergoing radiofrequency (RF) catheter ablation for elimination of atrioventricular (AV) accessory pathways (AP) associated with tachycardia, typically due to Wolff-Parkinson-White (WPW) syndrome, AV nodal re-entrant tachycardia (AVNRT), and creation of complete AV block in patients with difficult to control ventricular response to an atrial arrhythmia. The closed loop temperature control mode was used in the majority of patients, while the temperature sensing, or power control, mode was utilized at the investigators' discretion to maintain low power levels for certain ablations. This is referred to as the "Temperature Control" study.

10.2 Study Design

The investigation was a prospective, multicenter (six U.S. centers), open label study. Acute results were obtained during the study with the market approved RF generator and the investigational RF generator. These data were compared to the results from a similar study using a market approved RF ablation system. The results were also compared to the results of the Temperature Monitoring study. The long term results of the Temperature Monitoring study were deemed sufficient to support long term efficacy of the Temperature Control study as the same catheter and a similar generator were used.

10.3 Description of Patients

Of the 177 patients enrolled in the Temperature Control study, six (6) patients were discontinued prior to ablation; 171 patients underwent RF ablation. Of these, a non-protocol RF ablation system was used in addition to the investigational system in two (2) patients and four (4) patients had non-protocol arrhythmias. Tables 8 and 9 summarize this patient population.

Table 8. Temperature Control Patient Population

All patients in the temperature control study (n=171)

Indication	Core Patients	Supplemental Patients
WPW - Single AP	60	1 *
WPW - Two AP	5	0
AVNRT	82	1 *
AVNRT & WPW **	4	0
AVN Ablation	14	0
Non-protocol arrhythmias	0	4
Total	**165**	**6**

* a non-protocol RF ablation system was used in addition to the investigational system

** patients with AVNRT & WPW are reported under AVNRT for acute success and complication rates

Table 9. Enrollment and patient age by Indication

Indication for treatment	Number of patients		Age of patients (years)	
	%	#	Mean	Range
AVNRT[a,b]	51%	(87/171)	45	11, 80
WPW[b]	39%	(66/171)	31	10, 65
AVN Ablation	8%	(14/171)	64	34, 81
Other	2%	(4/171)	35	23, 44
Total	100%	(171/171)	41	10, 81

[a] - *Both WPW and AVNRT were present in 4 patients included in the AVNRT category*

[b] - *one a non-protocol RF ablation system was used in addition to the investigational system in two patients(1 each WPW and AVNRT)*

10.4 Gender Bias

For the 177 patients enrolled in the Temperature Control study, the mean age was 41 years; 55% were female and 45% were male. Inclusion criteria, exclusion criteria and study enrollment procedures were designed to avoid gender bias. This fraction of females (55%/45% = 1.22) is typical of ablation studies for these indications. No important differences in success rate or adverse event rate were detected between males and females in this patient population so the results presented are representative of both genders.

10.5 Follow-Up Schedule

All patients undergoing ablation returned for a follow-up visit 1-3 months post-ablation to undergo assessment for late procedure-related complications.

10.6 Comparison Study Population

Although the 171 patient Temperature Control study was not a randomized study, the results were compared to the results from the 584 patient Temperature Monitoring study, and to publicly available data from a similar 683 patient temperature control study using a market approved RF ablation system. The results of the Temperature Monitoring study were obtained under an approved IDE.

Table 10 summarizes the acute success and complication results from the studies involving the comparison populations. The patient populations from both the non-temperature and temperature sensing catheter studies (n = 755) were combined for indications, success rate and complications.

Table 10. Comparison Study Data Summary

Non-temperature sensing patients = 216; temperature sensing patients = 539

Catheter	Indication	Acute Success Rate	Minor Complications*	Serious Complications**
Cordis Webster (non-temp sensing)	WPW	93%	53% combined	2.2% combined
Cordis Webster (non-temp sensing)	AVNRT	96%		
Cordis Webster (temp sensing)	WPW	96%	50% combined	0.4% combined
Cordis Webster (temp sensing)	AVNRT	100%		
Market Approved System (n=683)	WPW, AVNRT, AVN Ablation	84%	13%	5%

* For the Cordis Webster studies, the "minor complications" category includes all reported events whether or not they were procedure or device-related, including pre-existing conditions.

** "Serious complications" category includes all deaths

Table 11 compares the long-term success rates of the comparison populations as the non-recurrence rate in those successfully treated.

Table 11. Summary of Long-Term Success Rate for Comparison Studies

All patients successfully treated in temperature control studies (n=901)

Catheter	Acute Success	2 months	6 months	12 months
Cordis Webster (non-temp sensing)	93%	97%	93%	91%
	n = 216	*n = 203*	*n = 165*	*n = 111*
Market Approved System	84%	94%	93%	91%
	n = 683	*n = 396*	*n = 248*	*n = 194*

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10.7 Statistical Analysis

Two related, but different analyses were performed. One analysis compared the acute procedural results and complication rates for the Temperature Control study to the publicly available data with the null hypothesis being that there is "no significant difference" between the results of the two studies.

The other analysis was a multivariate analysis comparing the acute results of the Temperature Control study to the Temperature Monitoring study to determine if generator type, arrhythmia type, age, or gender were predictors of success rate.

10.8 Effectiveness Results

Table 12 summarizes the acute success results for the Temperature Control study. A total of 1413 RF applications were delivered with a mean number of applications of 10.8 (range 1-42).

Table 12. Procedure Success by Indication
All patients in the temperature control study (n=171)

Indication	%	#	95% Confidence Interval	
AVNRT	97%	(84/87)	90%	99%
WPW	95%	(63/66)	87%	99%
AVN Ablation	100%	(14/14)	77%	100%
Other	75%	(3/4)	19%	99%
Total	96%	(164/171)	92%	98%

10.9 Statistical Analysis Results

Statistical analysis comparing the results of the Temperature Control study to the publicly available data rejected the null hypothesis ("no significant difference") in favor of the Temperature Control results.

Multivariate analysis of both studies involving Cordis Webster catheters showed no statistically significant difference in outcome based on gender, age, or generator type.

10.10 Safety Results

Table 13 summarizes the safety data for the Temperature Control study.

Table 13. Temperature Control Study - Complications
All patients in the temperature control study (n=171)

Indication	Minor Complications	Serious Complications
WPW	29%	2%
AVNRT	19%	1%
AVN Ablation	21%	7%
Total Core	**23%**	**2%**
Supplemental Patients	20%	17%

Serious, device-related complications were reported in three (3) patients, all of which had unintentional heart block requiring a pacemaker. In addition, one serious complication was reported which was a post-procedure intubation for a patient with chronic obstructive pulmonary disease and was not considered related either to the device or to the procedure. No deaths were reported during this investigation.

11. Conclusions Drawn from the Studies

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter when used with a market approved RF generator has been demonstrated to be reasonably safe and effective for elimination of AV accessory pathways associated with tachycardia, treatment of AV nodal re-entrant tachycardia, and for creation of complete AV block in patients with difficult to control ventricular response to an atrial arrhythmia.

11.1 Risk benefit analysis

Non-clinical testing demonstrated that the system meets or exceeds safety, reliability and performance specifications established by FDA and Cordis Webster, Inc. Fewer than 2% of patients in the clinical series had a serious complication (including death). Success rates and complication rates with this system are comparable to currently marketed ablation systems.

Therefore, it is reasonable to conclude that the benefits of use of the device for the target population outweigh the risk of illness or injury when used as indicated in accordance with the directions for use.

12. Panel Recommendation

In accordance with the provisions of section 515(c)(2) of the act as amended by the Safe Medical Devices Act of 1990, this PMA was not referred to the Circulatory System Devices Panel, an FDA advisory committee, for review and recommendation because the information in the PMA substantially duplicates information previously reviewed by this panel.

13. FDA Decision

FDA issued an approval order on September 30, 1997. FDA performed an inspection and found the applicant in compliance with the Good Manufacturing Practices (GMP) regulation (21 CFR, Part 820).

14. Approval Specifications

- Directions for use: See the labeling.
- Hazards To Health From Use Of The Device: See Indications, Contraindications, Warnings, Precautions And Adverse Events in the labeling.
- Post Approval Requirements and Restrictions: See approval order.
- The Approval Order, Summary of Safety and Effectiveness Data, and labeling can be found on the Internet at http://www.fda.gov/cdrh/pmapage.html.

Cordis Webster

Diagnostic / Ablation Deflectable Tip Catheter

INSTRUCTIONS FOR USE

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Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter

INSTRUCTIONS FOR USE

Caution: Federal law restricts this device to sale by or on the order of a physician (or properly licensed practitioner).

1. DEVICE DESCRIPTION

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter is a multi-electrode device which provides electrophysiological mapping of the heart and transmits radio frequency (RF) current to the catheter tip electrode for ablation purposes. For ablation, the catheter is used in conjunction with a compatible RF generator and a dispersive pad (reference electrode). Both temperature sensing and non-temperature sensing models are available.

The catheter has a high-torque shaft with a deflectable tip section containing an array of platinum electrodes. All electrodes may be used for recording and stimulation, but only the tip electrode may be used to deliver RF energy from the generator.

Tip deflection is controlled at the proximal end by a tubular handpiece in which a piston slides; a thumb knob on the piston controls piston travel. The plane of the curved tip can be rotated and the shape of the curve depends on the deflectable tip length. Six different curves, designated "A" through "F" (from 1.5" to 3.0" radius) are available. The catheter interfaces with standard recording equipment and a compatible RF generator via accessory extension cables with the appropriate connectors.

2. INDICATIONS

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter is indicated for cardiac electrophysiological mapping and for use with a compatible RF generator (see section 11.5) for:

- interruption of accessory atrioventricular (AV) conduction pathways associated with tachycardia;
- the treatment of AV nodal re-entrant tachycardia; and
- creation of complete AV nodal block in patients with a difficult to control ventricular response to an atrial arrhythmia.

3. CONTRAINDICATIONS

Do not use this device;

- in patients with active systemic infection;
- via the transseptal approach in patients with left atrial thrombus or myxoma, or interatrial baffle or patch;

- via the retrograde transaortic approach in patients with aortic valve replacement.

4. WARNINGS

Significant x-ray exposure, can result in acute radiation injury as well as increased risk for somatic and genetic effects due to the x-ray beam intensity and duration of the fluoroscopic imaging. Take all appropriate measures to minimize x-ray exposure to both patients and clinical staff.

Pregnancy -- Careful consideration should be given to the use of this device in pregnant women.

Ablation from within a coronary artery can cause myocardial injury and death. Adequate fluoroscopic visualization is necessary during the transaortic approach to avoid placement of the ablation catheter in the coronary vasculature.

Stroke or myocardial infarction may occur in patients undergoing **left-sided ablation procedures.** Patients should be closely monitored during the post-ablation period for clinical manifestations of embolic events.

Implantable pacemakers and implantable cardioverter/defibrillators (ICDs) may be adversely affected by RF ablation. ICDs should be deactivated during ablation. Have temporary external sources of pacing and defibrillation available during ablation. Exercise extreme caution during ablation when in close proximity to device leads and perform a complete analysis of the implanted device after ablation.

Complete AV block can occur when ablating septal accessory pathways or in the treatment of AVNRT. Closely monitor AV conduction during RF energy delivery and immediately terminate energy delivery if partial or complete AV block is observed. Using catheters with **distal pair electrode spacing greater than 2 mm** may increase the risk of AV nodal damage.

5. PRECAUTIONS

Cardiac ablation procedures should be performed only by appropriately trained personnel in a fully-equipped electrophysiology laboratory.

Do not attempt to operate the Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter or the RF generator prior to completely reading and understanding the applicable directions for use.

The long-term risks of protracted fluoroscopy have not been established. Careful consideration must therefore be given for the use of the device in prepubescent children.

The long-term risks of lesions created by RF ablation have not been established. In particular, any long-term effects of lesions in proximity to the specialized conduction system or coronary vasculature are unknown.

5.1 Catheter Compatibility

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter is intended for use with a compatible RF generator (see section 11.5) and Cordis Webster accessories only.

Read and follow the dispersive electrode manufacturer's instructions for use; the use of dispersive electrodes, which meet or exceed ANSI/AAMI requirements (HF18), is recommended.

5.2 Handling and Sterilization

SINGLE USE ONLY. Observe "Use By" Date. Sterilized with ethylene oxide gas.

The sterile packaging and catheter should be inspected prior to use. If the package or the catheter appears damaged, do not use. Contact your local Cordis Webster representative.

Catheter damage may occur due to

- autoclaving
- resterilizing
- exposure to organic solvents
- immersing proximal handle or cable connector in fluids

5.3 Environmental and EMI

Catheter materials are not compatible with magnetic resonance imaging (MRI).

Electromagnetic interference (EMI) produced by catheter may adversely affect the performance of other equipment.

5.4 Precautions During Catheter Use

The patient **should not contact grounded metal surfaces. Use only isolated amplifiers, pacing equipment, and ECG equipment** or patient injury or death may occur. Leakage current from any connected device to the patient must not exceed 10 microAmps (μA) under any circumstances.

Do not use excessive force to advance or withdraw the catheter. Careful catheter manipulation must be performed in order to avoid cardiac damage, perforation, or tamponade.

Do not insert or withdraw the catheter without straightening the catheter tip (pulling the thumb knob back)

Do not use the catheter if the small vent area at the connector end of the handpiece is clogged since air may be forced into the catheter lumen and into the bloodstream.

Use both **fluoroscopy and electrograms** to monitor the advancement the catheter to the area of the endocardium under investigation to avoid vascular or cardiac damage.

5.5 Precautions during Ablation

Do not increase power before checking for lead connection and appropriate dispersive electrode application. Effective contact between the patient and the dispersive electrode must be verified whenever the patient is repositioned.

Do not deliver RF energy with catheter outside the target site. The RF generator can deliver significant electrical energy and may cause patient or operator injury.

Avoid use of electrodes and probes of monitoring and stimulating devices which could provide paths for high frequency current. Reduce the burn hazard by placing the electrodes and probes as far away as possible from the ablation site and the dispersive electrode.

In the event of a generator cutoff (impedance or temperature), the catheter must be withdrawn and the tip electrode cleaned of coagulum before RF current is re-applied. Use only sterile saline and gauze pad to clean the tip.

Do not scrub or twist the tip electrode as damage may cause catheter failure or patient injury.

Discontinue ablation immediately and replace catheter if tip temperature fails to rise during ablation (temperature sensing model).

The temperature sensing model of the catheter measures electrode tip temperature, not tissue temperature. If the generator does not display temperature (temperature sensing model), verify that the appropriate cable is plugged into the generator. If temperature still is not displayed, there may be a malfunction in the temperature sensing system which must be corrected prior to applying RF power.

6. ADVERSE EVENTS

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter was studied in patients undergoing electrophysiologic (EP) mapping and RF catheter ablation. RF ablation was intended to eliminate atrioventricular (AV) accessory pathways (AP) associated with tachycardia due to Wolff-Parkinson-White (WPW) syndrome, AV nodal re-entrant tachycardia (AVNRT), or creation of complete AV nodal (AVN) block in patients with difficult to control ventricular response to an atrial arrhythmia. A total of 755 patients forms the safety database.

One patient died about 36 hours after transseptal puncture for left heart ablation. The investigational catheter was not used to deliver energy in this patient.

6.1 Observed Adverse Events

Eleven patients were reported as having major adverse events. They were either device-related, procedure-related, or unrelated to the device or procedure. Major adverse events were defined as

heart block requiring pacemaker or other adverse events requiring medical intervention or prolonged hospitalization. The 11 adverse events included complete heart block in 7 patients (6 requiring a pacemaker), two pericardial tamponades, one transient ischemic event, and intubation required in one patient with chronic obstructive pulmonary disease.

One fourth (26%) of patients reported one or more minor adverse events including dizziness, dyspnea, palpitations, chest pain, gastrointestinal symptoms, vision abnormalities, edema, and claudication.

Table 1. Observed Adverse Events

Categories are mutually exclusive, All patients treated with ablation (N=755)

Adverse Event	%	#	95% Confidence Interval*	
Minor	26%	(196/755)	23%	29%
Major	1.5%	(11/755)	0.73%	2.6%
Death	0.13%	(1/755)	0.0%	0.7%

** Confidence intervals by exact (binomial) method*

Table 2. Fluoroscopy time

All patients treated with fluoroscopy time measurement (N=580)

Catheter	Indication	Fluoroscopy Time (min) mean ± SD (range)
Non-Temperature	WPW	36 ± 37 (1, 248)
Non-Temperature	AVNRT	23 ± 21 (2, 255)
Temperature-Sensing	WPW	44 ± 41 (1, 223)
Temperature-Sensing	AVNRT	24 ± 22 (1, 129)

6.2 *Potential Adverse Events*

Adverse events (in alphabetical order) which may be associated with catheterization and ablation include:

***Catheterization/catheter procedure related*:**

- air embolism
- arrhythmias
- AV fistula
- cardiac perforation
- hemothorax
- pneumothorax
- pseudoaneurysm
- tamponade
- thrombi
- thromboembolism

- thrombosis
- valvular damage
- vascular bleeding/local hematomas
- vasovagal reactions

***RF ablation related*:**

- cardiac perforation/tamponade
- cardiac thromboembolism
- cerebrovascular accident (CVA)
- chest pain/discomfort
- complete heart block
- coronary artery dissection
- coronary artery spasm
- coronary artery thrombosis
- pericarditis
- transient ischemic attack (TIA)
- valvular damage
- ventricular tachyarrhythmia

7. CLINICAL STUDIES

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter was studied in conjunction with the Medtronic CardioRhythm Atakr RF generator (N=171, and with an investigational generator N=584) in patients undergoing EP mapping and RF catheter ablation. Clinical data from the N=584 population is not discussed in this section but has been used in the adverse event section of this document. RF ablation was intended to eliminate AV accessory pathways associated with tachycardia due to WPW syndrome, AVNRT, or creation of complete AVN block in patients with difficult to control ventricular response to an atrial arrhythmia.

Methods: In this prospective, multicenter (six centers), open label study, success was defined as the inability to induce the arrhythmia for WPW and AVNRT patients, and complete heart block for AVN patients. The closed loop temperature control mode was used in the majority of patients (versus temperature sensing or power control mode) at the investigators' discretion.

Results: Of the 177 patients enrolled, 171 patients underwent ablation and provide clinical data for assessment of safety and effectiveness. Slightly more than half (55%) of the patients were female. Table 3 describes the patient population by indication and age.

Table 3. Enrollment and patient age by Indication

All patients treated with Medtronic Atakr (N=171)

Indication for treatment	Number of patients		Age of patients (years)	
	%	#	Mean	Range
AVNRT[a,b]	51%	(87/171)	45	11, 80
WPW[a]	39%	(66/171)	31	10, 65
AVN Ablation	8%	(14/171)	64	34, 81
Other	2%	(4/171)	35	23, 44
Total	100%	(171/171)	41	10, 81

[a] - *Both WPW and AVNRT were present in 4 patients included in the AVNRT category*

[b] - *One non-protocol RF ablation system was used in addition to the investigational system in two patients(1 each for WPW and AVNRT)*

The four "Other" non-protocol arrhythmias treated included focal atrial tachycardia (N=3) and one AVN modification. A total of 1413 RF applications were delivered with a mean number of applications of 10.8 (range 1-42). Table 4 summarizes the acute success by indication.

Table 4. Procedure Success by Indication

All patients treated with Medtronic Atakr (N=171)

Indication	%	#	95% Confidence Interval	
AVNRT	97%	(84/87)	90%	99%
WPW	95%	(63/66)	87%	99%
AVN Ablation	100%	(14/14)	77%	100%
Other	75%	(3/4)	19%	99%
Total	96%	(164/171)	92%	98%

Serious, device-related complications were reported for three (3) patients all of which had unintended heart block requiring a pacemaker. In addition, one serious complication was reported which was a post-procedure intubation for a patient with chronic obstructive pulmonary disease and was not considered related either to the device or to the procedure.

8. INDIVIDUALIZATION OF TREATMENT

8.1 Antiplatelet or Anticoagulation Use

To avoid thromboemboli, intravenous heparin is used when entering the left heart during ablation, and many physicians prescribe aspirin, less often warfarin, for about 3 months afterward. No consensus yet exists about the need for short-term anticoagulation after ablation.

Left Heart Insertion

During the clinical study, systemic anticoagulation before intracardiac RF catheter ablation in the left heart was typically an initial intravenous heparin bolus of 3000 - 10,000 Units. Anticoagulation was maintained with an intravenous heparin drip or additional periodic intravenous boluses of heparin as necessary. Oral anticoagulation therapy may have been administered prior to ablation.

Investigators in the clinical trials typically prescribed long term (one to three months) anticoagulation therapy of one aspirin tablet daily, for patients undergoing left heart ablation, unless contraindicated.

Right Heart Insertion

During the clinical study, systemic anticoagulation was variable for patients undergoing intracardiac RF catheter ablation in the right heart. If used, systemic anticoagulation in the clinical study before ablation was typically an initial intravenous heparin bolus of 3000 - 10,000 Units followed by intravenous heparin drip or additional periodic intravenous boluses at a rate of 1000 Units/hour for the duration of the ablation procedure. Oral anticoagulation only, or no anticoagulation prior to ablation was also performed.

Long term anticoagulation therapy for patients undergoing right heart ablation was variable. Long term therapy of one aspirin tablet daily for patients undergoing right heart ablation may or may not be indicated.

8.2 Choosing Temperature or Power Control Mode

Please refer to the compatible RF generator's Directions for Use for information in choosing between temperature or power control modes.

8.3 Specific Patient Populations

The safety and effectiveness of cardiac ablation has not been established in:

- Asymptomatic patients;
- patients who are pregnant; or
- nursing mothers.

9. PATIENT COUNSELING INFORMATION

Patients may require anticoagulation and/or antiplatelet therapy for an indefinite period based on the patient's condition.

10. HOW SUPPLIED

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter is available with and without temperature sensing with the following options:

Six curve types:	A, B, C, D, E, F
Tip electrode:	4 mm tip, large (straight) or grooved (concave)
Connector type:	Redel 10-pin connector (temperature sensing model)
	Nexus plug (non-temperature sensing model)
Spacing:	Standard 2-5-2 spacing (center to center measurement of ring electrode spacing)

10.1 Packaging

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter is supplied STERILE. The catheter is placed into a thermoformed plastic tray designed to retain the catheter from movement. The tray is sealed with a Tyvek®/plastic laminate lid which in turn is placed into a plastic header pouch with a Tyvek header. Both are heat sealed.

10.2 Storage

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter must be stored in a cool, dry place. Storage temperature should be between 5° and 25°C (41° and 77°F).

10.3 Shelf-Life

Accelerated aging tests support an expiration date of three years.

11. DIRECTIONS FOR USE

11.1 Physician Training

Physicians must be familiar with the techniques and appropriately trained for cardiac mapping and ablation procedures. All mapping and ablation procedures must be performed in a fully-equipped electrophysiology laboratory.

11.2 Detailed Device Description

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter and Cordis Webster interface cable are used in conjunction with a compatible RF generator which has been shown to be safe and effective for cardiac ablation and a dispersive pad (reference electrode). Two models of the catheter are available: the non-temperature sensing model and the temperature sensing model.

The temperature sensing model of the catheter is identical to the non-temperature sensing model with the addition of a temperature sensor and connecting wires. A schematic diagram of the non-

temperature sensing and temperature sensing models of the catheter and their connection to the compatible RF generator appears on the following page (Figure 1).

The distal tip of the Cordis Webster deflectable catheter has one 4mm tip electrode with straight or concave walls, and three smaller ring electrodes. The spacing between the tip electrode and first ring electrode is fixed at 2mm. The standard spacing between the first ring electrode and second ring electrode is 5mm; the standard spacing between the second ring electrode and third ring electrode is 2mm. All four electrodes may be used for recording and stimulation, however, only the tip electrode can be used to deliver radiofrequency current to the desired ablation site.

The distal tip of the catheter can be curved by advancing or retracting an internal "puller" wire which is controlled by the handpiece at the proximal end of the catheter. A piston in the handpiece is attached to the puller wire and can be moved via a thumb-knob. When the thumb-knob is pushed forward, the catheter tip bends; when the thumb-knob is pulled back, the tip straightens. The shape of the curve depends on the deflectable tip length (1.5"-3.0") and the location of the puller wire anchor (proximal or distal) in the deflectable tip. Six different curves, designated "A" through "F" are available (see Figure 2).

The catheter body is a single lumen tubing with a dual lumen tip portion. Conductor wires from the electrodes pass through the handle and terminate in a Redel 10-pin connector (temperature-sensing model) or a Nexus plug (non-temperature sensing model).

FIGURE 1: Schematic of the Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter, Interface Cable and Compatible RF Generator

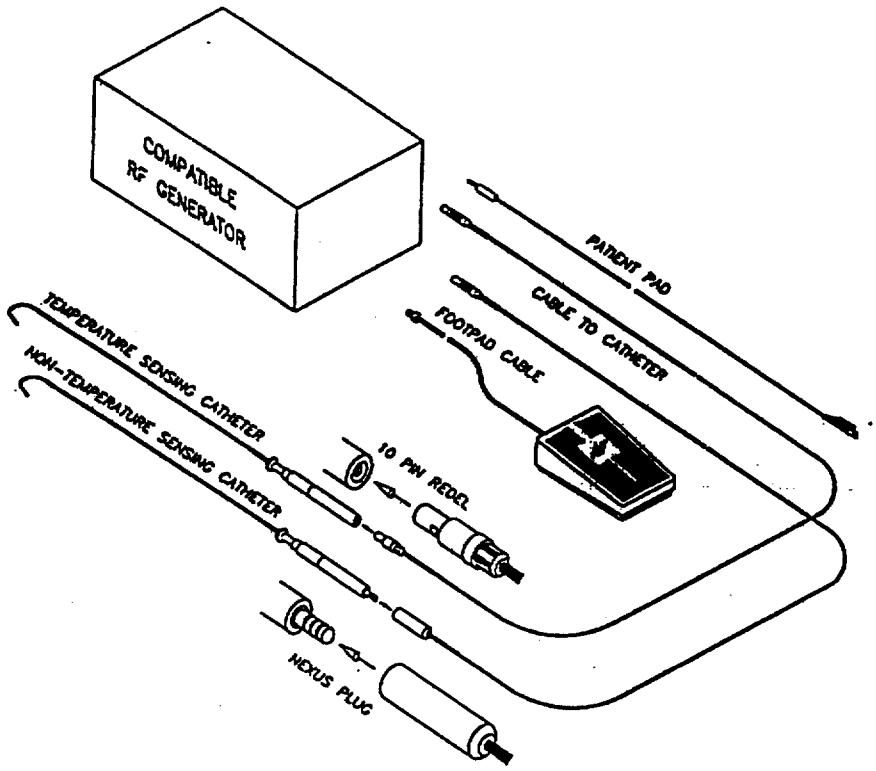
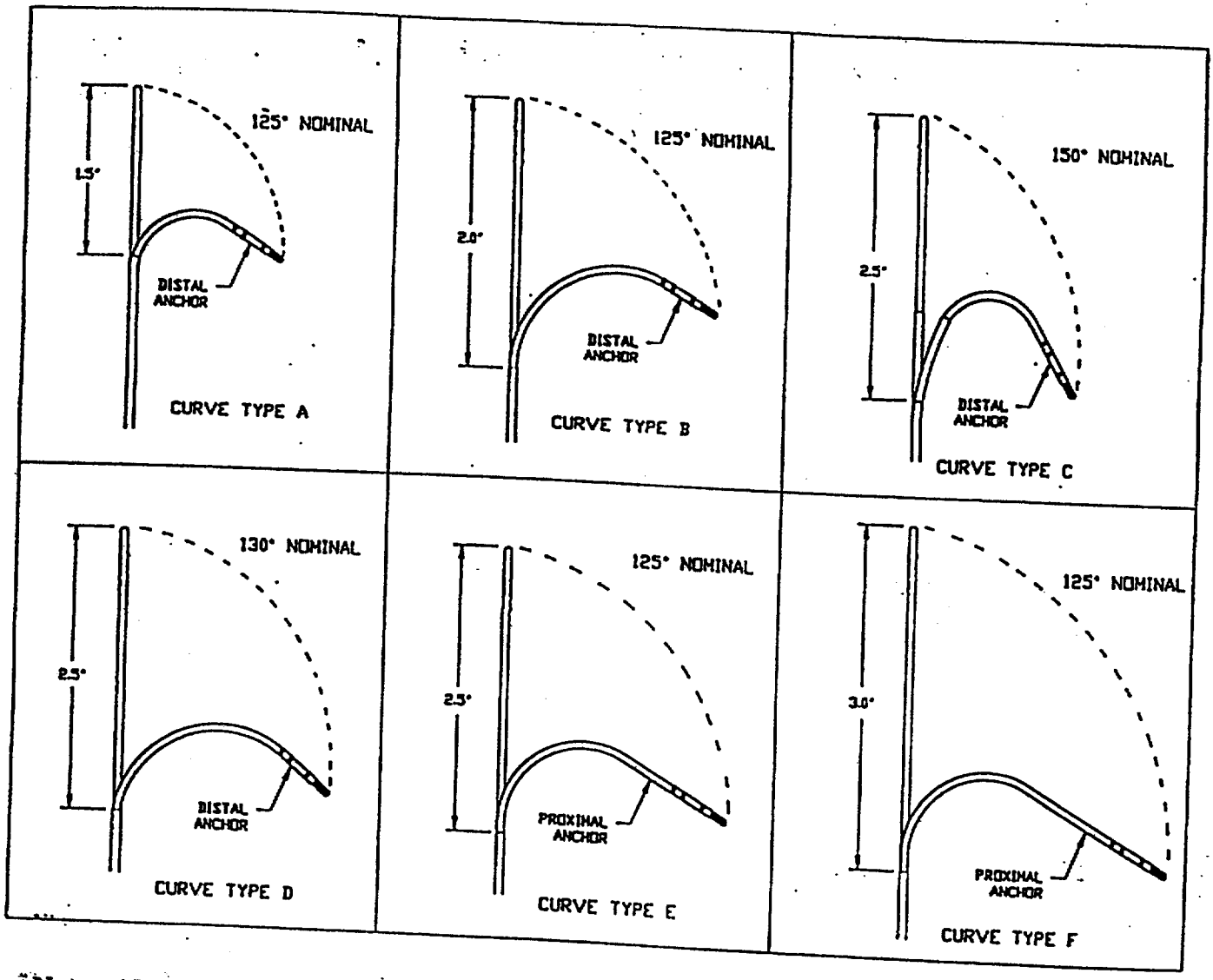


FIGURE 2: Deflectable Tip Catheter Curve Types



Note: Above deflection angles for 7 F; 6 F deflection angle is 90° minimum for all curves.

11.3 Handling and Preparation

Using aseptic technique, remove the catheter from its package and place it in a sterile working area. Inspect the catheter carefully for electrode integrity and overall condition.

11.4 Use During the Mapping and Ablation

1. Create a vascular access in a large central vessel using aseptic techniques and insert the catheter.
2. Connect the catheter to the recording equipment and/or a compatible RF Generator using the appropriate interface cables.
3. Advance the catheter to the area of the endocardium under investigation. Use both fluoroscopy and electrograms to aid in proper positioning.
4. The catheter tip can be deflected to facilitate positioning by using the thumb knob to vary tip curvature. Pushing the thumb knob forward causes the catheter tip to bend; when the knob is pulled back, the tip straightens.
5. When it has been determined that the tip electrode is in stable contact with the intended ablation site, the catheter tip electrode connection must be switched from the recording equipment to the RF generator in preparation for delivery of RF current.
6. RF current may be re-applied to the same or alternate sites using the same catheter.

11.5 Compatible RF Generators and Accessories

The Cordis Webster Diagnostic/Ablation Deflectable Tip Catheter should be used only with an RF generator which has been shown to be safe and effective for cardiac ablation.

Specifications for a Compatible RF Generator:

PARAMETER	SPECIFICATION
Thermometry	Thermocouple
Temperature Limit, maximum	100°C
Modes: (must operate in all 3 modes)	1. Temperature Control 2. Temperature Monitoring 3. Power Control
Maximum Output Power	50 Watts
RF output frequency	450 kHz - 550 kHz
Impedance cut-off	high: 250 Ω low: 40 Ω

Refer to the RF generator manual for detailed generator operating instructions for RF catheter ablation.

Specifications for Accessories:

Use appropriate Cordis Webster accessory cable to connect the Cordis Webster Diagnostic/Ablation Deflectable Tip catheter to a compatible RF generator.

PARAMETER	SPECIFICATION
Connector	Lemo 10 pin male to Redel 10 pin male (temperature sensing interface) Lemo 10 pin male to Nexus plug female (non-temperature sensing interface)
Length	6 ft. (183 cm)
Model numbers	C6-MR10/MLTC-S (temperature sensing interface) C6-FP/MLTC-S (non-temperature sensing interface)

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